SOMATIC CHROMOSOME NUMBERS FOR SOME ASTERACEAE

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Few plant groups can claim the attention of botanists that the American Asteraceae have been enjoying in recent years. In addition to thorough monographic studies an unprecedented series of chromosome number reports has appeared, and it may seem trivial to publish additional counts for a handful of miscellaneous taxa. Yet the need for repeated chromosome sampling cannot be stressed enough. Previous studies have revealed that intraspecific polyploidy is widespread, and chromosome counts from as many populations as possible throughout the range of each species are required to gain an idea of the nature and significance of this diversity. Many of the taxa discussed below are wide-ranging, polymorphous entities that have been counted but once or twice, making the "cytofloristic" approach imperative. The counts for *Artemisia saxicola* and *Haplopappus lyalli* are believed to be the first to be published for these species. A new ploidy level is established for *Chrysopsis fulcrata*.

MATERIALS AND METHODS

All chromosome counts were obtained from squashes of root-tips of young seedlings grown in the laboratory. Achenes were collected in the field in the late summer and fall of 1970. All germinated without special treatment in 2 to 9 days when placed on moist filter paper in Petri dishes and maintained at room temperature. Excised root-tips were pretreated in a saturated solution of 8-hydroxyquinoline for 3 hours, fixed in 1 : 3 acetic alcohol, and stained in lacto-propionic orceine (for details, see Kovanda 1970). The counts were verified in five or more plantlings. Voucher specimens were collected for all plants sampled and will be deposited at the Herbarium of the National Museum in Prague (PR). Duplicates, when available, will be deposited

in the United States National Herbarium (US). A portion of the material examined has been planted in the experimental plot of the Botanical Institute, Czechoslovak Academy of Sciences, Prague, for future observations. All collections were made by Kovanda or by Kovanda and S. G. Shetler.

OBSERVATIONS

Tribe Vernonieae

1. *Elephantopus carolinianus* Willd.
Maryland, Montgomery County: thicket along Chesapeake & Ohio Canal near Glen Echo, vicinity of Washington, D.C., *Kovanda* 3558. $2n = 22$.

This species recently has been examined cytologically from two widely separated areas: Virginia (Baldwin & Speese, 1955) and Texas (Lewis et al., 1962). In both cases, the authors report the same chromosome numbers, $2n = 22$ and $n = 11$, respectively. The entire genus seems to have the base number $x = 11$, and all species counted heretofore have proved to be diploid. The count $2n = 44$ for *E. tomentosus* L., ascribed by Fedorov et al. (1969) to S. B. Jones (1966), is in error, Jones having counted $n = 11$ and listed the earlier count of $2n = 22$ made by Baldwin & Speese.

Tribe Eupatorieae

2. *Eupatorium coelestinum* L.
Maryland, Montgomery County: dry woodland near Cabin John Bridge, vicinity of Washington, D.C., *Kovanda* 3529. $2n = 20$.

This number was reported previously by Grant (1953) for material from Pennsylvania, Kentucky, and Tennessee. By its chromosome morphology this species differs from all other species of *Eupatorium* having $x = 10$ and would be best referred perhaps to the genus *Conoclinium* DC. (see Grant 1953).

3. *Liatris punctata* Hook.
Colorado, Larimer County: Rist Canyon, grassy roadside about 8 mi. W. of Bellevue, 6800 ft., *Kovanda & Shetler* 3169. $2n = 40$.

In her study of the genus *Liatris*, Gaiser (1950) has demonstrated that two chromosome races exist in this species, which she was able to identify with previously described infraspecific taxa. Diploids ($2n = 20$) have been referred to var. *nebraskana* Gaiser, and the tetraploid level ($2n = 40$) is represented in var. *punctata* (var. *typica* Gaiser) and var. *mexicana* Gaiser. The two cytotypes are not always easily recognizable on a morphological basis but show, in addition to marked differences in the beginning of anthesis, also a clear geographical separation. Tetraploids seem to occur throughout most of the extensive range of the species (with var. *mexicana* being limited to its southern part) while the diploid variety is obviously localized. The Rist Canyon population certainly falls within the typical variety but approaches somewhat var. *nebraskana* by its leaves which are almost entirely devoid of cilia.

TRIBE ASTEREAE

4. *Aster occidentalis* (Nutt.) T. & G.
Colorado, Larimer County: brushy hillside north of Stove Prairie School, S. of Poudre River, 6500 ft., *Kovanda & Shetler* 3183. $2n = 16$.

The count reported here is consistent with those published by Huziwara (1958, 1959) and Solbrig et al. (1969). The Western Aster is one of the few aster species not in the $x = 9$ series. The number $x = 8$, likewise $x = 5$ in *A. exilis* Ell. and *A. foliaceus* Lindl., and $x = 13$ in *A. chilensis* Nees, is clearly secondary (Solbrig et al., 1969). Other species with $x = 8$ include, for instance, *A. adscendens* Lindl., *A. ericoides* L., *A. hirtifolius* Blake, *A. lateriflorus* (L.) Britt., and *A. puniceus* L.; most of them are tetraploid, with $2n = 32$. It is interesting to note that base numbers other than $x = 9$ are not known to occur in species native to the Old World, which supports the contention that the center of origin of this huge genus is America.

5. *Chrysopsis fulcrata* Greene
Colorado, Clear Creek County: abandoned campground in Clear Creek valley, about 12 mi. south of Georgetown, 11,440

ft., *Kovanda & Shetler* 3331. $2n = 18$.
Colorado, Larimer County: Rist Canyon, grassy roadside about 8 mi. west of Bellevue, 6800 ft. *Kovanda & Shetler* 3172. $2n = 36$.

Counts by Raven et al. (1960), Turner et al. (1962), Solbrig et al. (1964), Chuksanova et al. (1968), and Solbrig et al. (1969) indicate that both diploids and tetraploids are present in the *Chrysopsis villosa* species aggregate. In *C. fulcrata*, a segregate defined mainly by leaf-like bracts subtending the heads, glandular phyllaries and sessile leaves, only the diploid level ($n = 9$) has been sampled (Solbrig et al. 1964, 1969). An examination of material from Rist Canyon clearly showed 36 somatic chromosomes. The collection was compared with Greene's type material of *C. fulcrata* in the U. S. National Herbarium, and no specific differences could be seen except for the leaves. These are sometimes slightly tapering at the base in my plants but are distinctly semi-amplexicaul in the type specimen, collected in the Organ Mountains, New Mexico. In the Clear Creek diploid this tapering is even more conspicuous, marking an intergradation with *C. hispida* (Hook.) DC. and *C. viscida* (A. Gray) Greene. The taxonomy of the entire complex is not very well understood, and there appears to be little correlation between the cytological findings and morphological segregation of the several species.

6. *Chrysothamnus nauseosus* (Pallas) Britt. subsp. *nauseosus*
Wyoming, Albany County: stony roadside just east of Centennial, 8000 ft., *Kovanda & Shetler* 3205. $2n = 18$.

The Rabbitbrush was the subject of a detailed cytotaxonomic study by Anderson (1966) who demonstrated that polyploidy is rare in this genus. He found only the diploid number $2n = 18$ in many plants of *C. nauseosus* divided among 12 subspecies. The same number has been counted by Raven et al. (1960) and Solbrig et al. (1964). The count reported here is only a further proof (if one is needed) that the astonishing morphological variation shown by this species cannot be credited to polyploidy.

7. *Erigeron speciosus* (Lindl.) DC.
Wyoming, Teton County: Teton Pass, 9000 ft., *Kovanda & Shetler* 3252. $2n = 18$.

Previous counts seem to indicate that this species comprises diploid and tetraploid cytotypes. Ferri (1961), Zhukova (1964, 1967) and Huziwara (1965) give, alternatively, $n = 9$ or $2n = 18$, contrasting with $2n = 36$ counted by Vilmorin and Chopinet (1954). Unfortunately, all these counts were made on cultivated material of uncertain origin, and it remains to be seen whether both the races occur in natural habitats. The Teton Pass population proved to be diploid and appears referable to var. *macranthus* (Nutt.) Cronquist, which has been counted as *E. macranthus* Nutt. by Bergman (1942) and Zhukova (1964). Both counts were $2n = 18$, too, but the sources of the material were not given.

8. *Grindelia aphanactis* Rydb.
New Mexico, Rio Arriba County: Rio Grande Canyon, about 5 mi. NE. of San Juan Pueblo, 5800 ft., *Kovanda* 3404. $2n = 24$.

The only previous count for this species was $n = 12$ by Raven et al. (1960) on material from Arizona. *Grindelia* Willd. is a natural genus, and, chromosomally, a very homogeneous one, with the base number only $x = 6$. The majority of species seem to be diploid, with $2n = 12$ (see also Whitaker and Steyermark 1935, Dunford 1964, 1970).

9. *Haplopappus lyallii* A. Gray
Colorado, Clear Creek County: Loveland Pass, 11,900 ft., *Kovanda & Shetler* 3382. $2n = 18$.

No previous cytological work seems to have been done on this tiny goldenweed. Two members of the section *Tonestus*, *H. eximius* Hall and *H. peirsonii* (Keck) Howell, have been shown to have $2n = 18$ and ca. 90, respectively (Stebbins *in* Howell 1950), which would indicate that the base number for that group is 9. But considering the variety of chromosome numbers encountered in other species (see e.g., Raven et al. 1960, Solbrig et al. 1964, 1969), any such statement would be premature. In the genus *Haplopappus*,

as broadly conceived by Hall (1925), $x = 9$ as a basic chromosome number is not uncommon; however, it is puzzling to discover that it is largely associated with the shrubby groups of the southwestern deserts, such as sections *Ericameria* and *Stenotopsis*. The only other herbaceous species hitherto known to have the base number $x = 9$ is *H. clementis* (Rydb.) S. F. Blake of the section *Pyrrocoma*. The genus *Tonestus* was proposed by Nelson (1904) to accommodate low perennial herbs from the Rocky Mountains area and "to bring together under one name these species [*H. laceratus* Henderson, *H. lyallii* A. Gray, and *H. pygmaeus* T. & G.] which are allied by habit and morphological characters to each other and are aberrant in any recognized genus or genera in which they can be placed." When more cytological information is available, it may become necessary to reconsider the generic and sectional limits.

10. *Solidago flexicaulis* L.
Maryland, Harford County: woodland along Susquehanna River below Deer Creek, between Schweers Landing and Lapidum, *Kovanda & Shetler* 3638. $2n = 18$.

The same diploid number has been found in plants from several Canadian localities (see Beaudry and Chabot 1959, Kapoor and Beaudry 1966, Kapoor 1970). A tetraploid cytotype was reported from Michigan (Solbrig et al. 1964).

11. *Solidago multiradiata* Ait.
Colorado, Clear Creek County: Clear Creek valley, about 12 mi. west of Georgetown, 11,400 ft., *Kovanda & Shetler* 3372. $2n = 18$.

This arctic-alpine species was once thought to be diploid (Beaudry and Chabot 1959, Beaudry 1963) but has recently been shown to have tetraploid races, $2n = 36$, in western Canada and Alaska (Taylor 1967, Johnson & Packer 1968, Packer 1968). The count recorded here is the first made on material from the Southern Rockies where the species reaches its southernmost limit. The collection is var. *scopulorum* A. Gray.

12. *Solidago sempervirens* L.
Delaware, Sussex County: salt marsh about 2 mi. S. of Rehoboth Beach, *Kovanda* 3589. $2n = 18$.

Several counts have been made on this halophyte, revealing the presence of diploid and tetraploid levels. However, these races do not correspond with the two major segments recognized taxonomically within *S. sempervirens*. The southern entity, var. *mexicana* (L.) Fern., was first reported to be diploid but was later found to have also $2n = 36$, and the same holds for the more northern var. *sempervirens* (Goodwin 1937, Beaudry and Chabot 1959, Beaudry 1963, Kapoor 1970). Likewise, the geographical distribution of the cytotypes does not seem to form a definite pattern, but there are too few counts to allow any generalization. Their morphological differences and ecological preferences, if any, also await future research.

TRIBE HELIANTHEAE

13. *Rudbeckia hirta* L.
Maryland, Frederick County: Catoctin Mountains, old field near cabin of David Scott, west of Thurmont, *Kovanda* 2896. $2n = 38$.
Colorado, El Paso County: Pikes Peak, 9000-foot level, streamside, *Kovanda & Shetler* 3398. $2n = 38$.

Rudbeckia hirta is an extremely variable species, and many local variants have been given varietal or specific rank. Perdue (1957) greatly reduced their number by recognizing five geographical varieties: var. *hirta*, var. *pulcherrima* Farwell, var. *corymbifera* Fernald, var. *angustifolia* (T. V. Moore) Perdue, and var. *floridana* (T. V. Moore) Perdue. Most controversial perhaps is the treatment of var. *pulcherrima* which was first described as *R. serotina* Nutt. and to which both the populations sampled by the present author belong. Fernald (1948) considered it a western entity which had spread eastwards, becoming thoroughly naturalized throughout most of the United States, and advocated its specific status. His ideas, however, received little support from later workers (Perdue 1957, Core 1962). In contrast to its intricate morphological struc-

ture, the species complex appears remarkably uniform in cytology, $2n = 38$ being the only chromosome number so far obtained (Battaglia 1946, 1947, Perdue 1959). The same chromosome number has also been reported for *R. serotina* (Battaglia 1947, Mulligan 1959).

14. *Viguiera multiflora* (Nutt.) S. F. Blake
Utah, Daggett County: Uinta Mountains, between Cub Creek and Y Creek, ca. 6 mi. W. of Red Canyon Road, 8500 ft., *Kovanda & Shetler* 3275. $2n = 16$.

Two earlier counts for this species give the gametic chromosome number as $n = 8$ (Heiser and Smith 1955, Heiser 1963).

TRIBE HELENIEAE

15. *Hymenoxys richardsonii* (Hook.) Cockerell
New Mexico, Santa Fe County: 2 mi. NE. of Santa Fe, 7200 ft., *Kovanda* 3428. $2n = 30$.

The chromosome number of this species has been determined repeatedly as either $n = 15$ or $2n = 30$ (Speese and Baldwin 1952, Strother 1966). The count $2n = 28$, made by Taylor and Brockman (1966) on a collection from Saskatchewan, suggest that there are two chromosome races in this species whose morphology and geographical distribution require further study. Material examined by the present author belongs to var. *floribunda* (A. Gray) Parker and was collected in or near the type locality ("rocky hills, as well as plains and creek bottoms, around Sante Fe", A. Gray in Mem. Amer. Acad., n.s. 4: 101, 1849).

16. *Pericome caudata* A. Gray
New Mexico, Santa Fe County: Sangre de Cristo Mountains, along the Chamisa Trail, 7600 ft., *Kovanda* 3426. $2n = 36$.

Pericome caudata has recently been counted by Turner and Flyr (1966) and Powell (1968). Both obtained a gametic chromosome number of $n = 18$. Raven and Kyhos (1961) have found the same number in the closely related *P. glandulosa* Goodm. It would appear that the small genus *Pericome* has the base number $x = 9$.

TRIBE ANTHEMIDEAE

17. *Artemisia borealis* Pallas

Colorado, Clear Creek County: Loveland Pass, 11,990 ft., *Kovanda & Shetler* 3376. $2n = 18$.

Artemisia borealis is taxonomically complex in the Old and New World, and attempts to subdivide it into more natural entities have not been very successful. Diploids and tetraploids, based on $x = 9$, are known to exist in this group. Both these races have been shown to occur in North America, but their disposition is not at all clear. Diploids ($2n = 18$) have been discovered in Greenland (Jörgensen et al. 1958), northern Quebec (Hedberg 1967), and Alberta (Packer *in* Johnson and Packer 1968), but tetraploids ($2n = 36$) have so far been found only in Alaska (Johnson and Packer 1968). The Loveland Pass record is important because the count was made on material from the most southern portion of the species range. The plants examined have basal leaves three times pinnatifid, densely hairy on both surfaces; stems almost totally glabrous; heads erect, arranged in a narrow, spike-like inflorescence, somewhat interrupted in the lower half; phyllaries villous; achenes silky-hairy.

18. *Artemisia frigida* Willd.

Colorado, Park County: 2 mi. N. of Fairplay on Route 9, 9900 ft., *Kovanda & Shetler* 3379. $2n = 18$.

This number was obtained previously by Löve and Löve (1964) on plants from Manitoba and by Knaben (1968) on plants from Alaska. Kawatani and Ohno (1964) give $2n = 18$ for garden material of unspecified origin.

19. *Artemisia saxicola* Rydb.

Colorado, Grand County: alpine tundra above Berthoud Pass, 12,400 ft., *Kovanda & Shetler* 3324. $2n = 18$.

Colorado, Summit County: near Pass Lake, just S. of Loveland Pass, 11,000 ft., *Kovanda & Shetler* 3367. $2n = 18$.

These are probably the first counts for the Rocky Mountains segregate of *A. arctica* Less. This species, ranging in northeastern Asia and northwestern North America and

itself a segregate of the European *A. norvegica* Fries, has been counted many times on Asiatic material and is known to have two chromosome numbers, $2n = 18$ and 36. (Kitamura 1957, Sokolovskaya 1963, Kawatani and Ohno 1964, Zhukova 1964, 1965, 1967). Only two records are available from North America (Johnson and Packer 1968, Taylor and Mulligan 1968). Both counts are tetraploid and were made on plants from Alaska and the Queen Charlotte Islands, respectively. It is extremely interesting to discover that the Rocky Mountain populations are diploid and, therefore, more primitive than the northern *A. arctica.* This, combined with the geographical isolation and a degree of morphological differentiation, would justify the specific rank assigned to this race by Rydberg but disregarded by most later students.

TRIBE SENECIONEAE

20. *Senecio longilobus* Benth.
New Mexico, Santa Fe County: near Bishop's Lodge, N. of Santa Fe, 6900 ft., *Kovanda* 3425. $2n = 40$.

This number conforms to the findings of Jackson (1959) and Ornduff et al. (1967) who determined $n = 20$ on plants from New Mexico and Texas. Powell and Turner (1963) have reported the same chromosome number for Mexican material under the name of *S. filifolius* Nutt. The section *Suffruticosi,* confined to the western United States and northern Mexico, appears chromosomally uniform. All species hitherto examined have proved to have $n = 20$ (Stoutamire and Beaman 1960; Turner, Ellison and King 1961; Ornduff et al. 1963, 1967), and Ornduff et al. (1963) have proposed that the base number is either $x = 10$ or $x = 20$.

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